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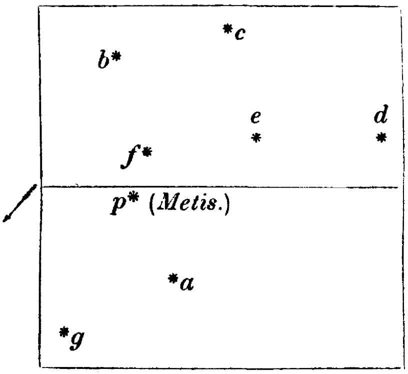
Sir William R. Hamilton handed in the following diagram, representing (rudely) the manner in which the planet Metis was seen on April 28, 1848, in an inverting telescope:



On April 30, 1848, the other seven stars, *a*, *b*, *c*, *d*, *e*, *f*, *g*, of this group, retained their respective positions; but the planet *Metis* had withdrawn from the position *p*, and had left the (circular) *field* indicated above, in the direction of the arrow.

The planet was thus seen at the Observatory of Trinity College, Dublin, in consequence of information from the discoverer, Mr. Graham, principal assistant to E. J. Cooper, Esq.

Mr. Donovan read a paper "On several Improvements in the Construction of the Galvanometer; on Galvanometers generally; and on a new Instrument for measuring and ascertaining the Distribution of Magnetism in Needles intended to be astatic, and for communicating to them greater sensibility."

The galvanometer, in the present day, has become a most important instrument of research, whether it be considered as a measure of electricity or of heat. In the latter capacity it exceeds all others in sensibility, and the promptness of its indications. But the construction at present in use is liable to the interference of circumstances which lessen its sensibility, and occasionally lead to errors of no small magnitude. The errors of construction were described by Mr. Donovan, and shown to be of such kind, that, in the attempt to preserve sensibility, we sacrifice it by introducing a new source of deception. A method of remedying these errors without such a sacrifice was pointed out. Exceptions were taken against the method at present in use for placing the galvanometer in the magnetic meridian; it was stated to be altogether inadequate; and remarks were made on the influence of this error on the indications of the instrument. An improvement in the galvanometer in this respect was described.

Galvanometers, as at present constructed, possess either too much or too little directive power: in the former case they are insensible to weak forces; in the latter they fail to indicate strong ones, because the maximum effect is produced by very feeble sources of power. The new galvanometer contains different provisions against these imperfections.

Several curious and important properties of the needle commonly called astatic were noticed; and some consequences highly detrimental to its proper action, and conducive to greater error in its indications, were fully described. A new instrument, called a *volta-magnetometer*, was exhibited, which detects and remedies these errors. A new method of magnetizing needles, and a new construction of needles, along with several observations on the defects of those at present in use, were introduced to the notice of the Academy.

Instruments exhibiting the defects of the present construction of galvanometers, as well as others in which these defects have been remedied, lay on the table during the reading of this paper.

The conclusion of the paper was as follows: "The improvements in the construction of galvanometers here suggested may be summed up as follows: 1. the addition of means, independent of the astatic needle, for setting the instrument in the magnetic meridian; 2. the close approximation of the needles to the coil; 3. the removal of obstructions to the rotation of the needles; 4. the means of inducing in the needles the least difference of polarity that is consistent with their function; 5. a method of detecting and preventing derangement of the needles, arising from forces which cause in them a tendency to stand transversely to their true position; 6. a construction of the needles which renders available the operation of a strong or a weak directive force, as may be required; 7. the introduction of a controlling graduated magnetic power for regulating the deflecting influence of voltaic forces on the needles.

"I venture to hope that those improvements, along with the several adjustments and facilities added, will render the instrument more convenient, will increase its sensibility, and contribute to the accuracy of its indications."

The President observed, that all the facts respecting the position of equilibrium of the astatic needle, to which Mr. Donovan had directed the attention of the Academy, and which (as far as he was aware) he has been the first to notice, were simple and immediate consequences of theoretical laws.

When two magnetic needles are united by a fixed vertical axis passing through their centres, and perpendicular to both, the moment of the force exerted by the earth upon them is the sum of the moments which it exerts upon each needle separately, and is, therefore,

$$X(M \sin u + M' \sin u');$$

in which M and M' denote the *magnetic moments* of the two needles, u and u' the angles which their *magnetic axes* make with the magnetic meridian, and X the horizontal component of the earth's magnetic force. In the state of equilibrium this moment is nothing; so that if u_0 and u_0' denote the corresponding values of u and u', there is

$$M \sin u_0 + M' \sin u_0' = 0. \qquad (1)$$

Consequently, if two lines be taken from any point of the vertical axis, parallel to the magnetic axes of the two needles, and proportional to their magnetic moments, M and M', the diagonal of the parallelogram constructed upon them must lie in the magnetic meridian, when the compound needle is at rest.

Again, if we substitute $u = u_0 + v$, $u' = u_0' + v$, in the general expression of the statical moment, it becomes, in virtue of (1),

$$X(M \cos u_0 + M' \cos u_0') \sin v.$$

Hence the compound needle is acted upon as a single needle, whose *magnetic axis* lies in the direction of the diagonal of the parallelogram above mentioned, and whose *magnetic moment* is

$$\mu = M \cos u_0 + M' \cos u_0'. \qquad (2)$$

Accordingly, the diagonal of the parallelogram already referred to will represent in magnitude the magnetic moment of the compound needle. For, if the equations (1) and (2) be squared, and added together, and the angle contained by the magnetic axes of the two needles, $u_0' - u_0$, be denoted by a, we have

$$\mu^2 = M^2 + 2MM' \cos a + M'^2. \qquad (3)$$

In the case of the *astatic* needle, $a = 180 - \delta$, δ being a very small angle, and $\cos a = -\cos \delta = -1 + \frac{1}{2}\delta^2$, *q.p.* whence

$$\mu^2 = (M - M')^2 + M M' \delta^2. \qquad (4)$$

Accordingly, when $M - M'$ is not a very small quantity, the second term may be neglected in comparison with the first, and $\mu = M - M'$, nearly. On the other hand, when $M - M' = 0$, we have $\mu = M \delta$.

Returning to (1), and substituting for u_0' its value $u_0 + a$, we have

$$\tan u_0 = \frac{-\sin a}{\frac{M}{M'} + \cos a}; \qquad (5)$$

by which the position of the needle with respect to the magnetic meridian, when at rest, is determined. In the case of the astatic needle the preceding equation becomes

$$\tan u_0 = \frac{-M'}{M-M'} \cdot \delta \sin 1'. \qquad (6)$$

From this we learn,

1. That the tangent of the angle of deviation of the astatic needle from the magnetic meridian varies, *cæteris paribus*, as the angle, δ, contained by the magnetic axes of the two component needles.

2. That however small that angle be, provided it be of finite magnitude, the tangent of the deviation may be rendered as great as we please, and therefore the deviation be made to approach to 90° as nearly as we please, by diminishing the difference of the moments of the two needles.

Sir W. R. Hamilton communicated the following double mode of generation of an ellipsoid, which had been suggested to him by his quaternion formulæ.

Conceive two equal spheres to *slide* within two cylinders, in such a manner that the right line joining their centres may remain parallel to a fixed line; then the locus of the varying circle in which the two spheres intersect each other will be an *ellipsoid*, inscribed at once in both the cylinders, so as to touch one cylinder along one ellipse of contact, and the other cylinder of revolution along another such ellipse.

And the *same* ellipsoid may also be generated as the locus of *another* varying circle, which shall be the intersection *of another pair of equal spheres*, sliding within the same pair of cylinders, but having their line of centres constantly parallel to another fixed line. Every ellipsoid can be generated by the above double mode of generation.

Professor Graves read the first part of a paper on the Ogham Character.